GRAPHITE METAL COATING

[0001] This application is a Continuation-in-Part of PCT/EP02/03116, filed on 20 March 2002.

FIELD OF THE INVENTION

[0002] The present invention involves a method for applying a metal coating to graphite.

BACKGROUND OF THE INVENTION

[0003] Graphite is used as a material in a huge variety of applications. In many cases, graphite members have to be used for electrically conductive connections, where one often only uses clamp connections or creates a contact by pressing on other electrically conductive parts (in particular by pressing on metal contacts). In order to address many technical problems, however, a connection created by soldering or other connecting techniques is required, thus making a metallic surface of the graphite member mandatory.

SUMMARY OF THE INVENTION

[0004] One object of the invention is to provide an improved method for applying a metal coating to graphite.

[0005] Another object of the invention is to ensure a good adhesion between the applied metal layers and the graphite surface itself.

[0006] These and other objects are attained in accordance with one aspect of the invention directed to a method for applying a metal coating to graphite that includes the steps of anodic etching the graphite in an alkaline etchant, and then electroplating the graphite.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0007] One aim of the invention is to ensure a good adhesion between the metal layers to be applied and the graphite surface itself. The inventor has discovered, that a good adhesion can be accomplished when the graphite structural member is first pre-treated and activated by anodic etching in an alkaline etchant, and is subsequently electroplated. Anodic etching is done with an applied electrical potential, the grapite being the anode. By means of the anodic etching in the alkaline etchant, the graphite surface is not only thoroughly cleansed but also slightly etched, whereby the subsequent electroplating is accomplished on a surface which is mainly free of foreign impurities and graphite dust, and which is slightly roughened. Accordingly, the metal layer can effectively interlock with the graphite surface, thereby providing significant adhesive properties. The alkaline etchant thus creates the condition for such metal coatings to have a high adhesive strength and temperature stability.

[0008] Optionally, the graphite surface can be Pd seeded prior to electroplating. In addition, subsequently to this Pd seeding one may deposit a so-called chemical metal

layer. This refers to a metal deposition by means of a reducing agent without applying current (electroless plating). This electroless plating is optional, but is preferably based on the Pd seeding. The electroless plating preferably deposits Ni or Cu. These two metals may also be present together or in a combination with other metals.

[0009] The cleansing effect of the alkaline etchant may additionally be enhanced by an ultrasound treatment. This helps to detach particles adhering to the surface and, furthermore, it is effective to mix thoroughly and to equalise the concentrations in the surface surroundings. This ultrasound treatment, however, has several disadvantages. In some structural members it is undesirable due to the mechanical stress exerted on sensitive parts. Furthermore, it requires the incorporation of the members into a device suitable for the ultrasound treatment. In order to optimise the uniformity of the ultrasound treatment, one can select in particular annular configurations of the batches of structural members to be treated, which however is rather complicated with respect to the machinery.

[0010] According to a particularly preferred feature of the invention, the described ultrasound treatment is completely omitted and the temporal and technical effort is, thus, significantly reduced. Instead of this, the treated graphite members taken out of the alkaline etchant are directly (i.e. in a direct succession without any further intermediate treatment) dipped into a weak aqueous solution or into water. Thereby, at the surfaces of the members, strong gradients of concentration are produced due to the residual portions of the solution employed for the etchant. These residual parts of the etchant show a short and rather intensive reaction with the water or the weak aqueous

solution, which becomes obvious by the temporary sparkling in the water or in the aqueous solution near the surface. This sparkling effect, according to the inventor's observation, has a cleansing effect similar to the ultrasound bath, and effectively and easily removes from the surface those impurities already being etched off or being loosened by the etchant.

[0011] The process just being described is thus preferably to be used to completely omit an ultrasound treatment at least in this field of the method.

[0012] The described electroplating of graphite may be accomplished on a mounting apparatus and, in case of a specific geometry or shape of the members, in drums. The electroplating can preferably employ Ag, Cu, Ni or Sn, or a mixture of these metals, or a mixture of one or several of these metals with other metals. In particular Sn and Sn-alloys have good soldering characteristics, so that the galvanic layer provides a good basis for a subsequent (optional) soldering step.

[0013] Thus, after the etching process, one can preferably apply either

- a Pd seeding + chemical Ni + Cu (or Ni)
- or galvanic Ni directly after the rinsing
- or galvanic Cu directly after the rinsing.

[0014] These layers are then used as a basis for the deposition of further layers (Sn or other metals).

[0015] Preferred parameter ranges for the electroplating are a current density in the range 0.1 to 10 A/dm^2, and a duration of treatment, i.e. bath and current duration, in the range 5 to 90 minutes.

[0016] The anodic etching can preferably be performed in a sodium hydroxide solution (solution of NaOH) or in a potassium hydroxide solution (solution of KOH) or in a mixture of both lyes, for example in range of concentration of 10 to 70 % by weight, with a particularly preferred range of 20 to 50 % by weight. For this aim, temperatures of 20° to 70°C have achieved good results, with temperatures in the range of 30°C to 40°C being preferable.

[0017] The term "graphite" in this invention refers to all materials in which graphite is contained in such a degree and is present on the relevant surface, that applying a metal coating of the graphite surfaces themselves is essential to attain the desired technical result. This, of course, includes all pure graphite materials as well as those containing minor additives. Preferably, however, the invention is also directed to plastic-bound graphite materials in which graphite particles are contained within a plastic matrix. Such material serves various technical applications, in which the method according to the invention can be of great advantage.

[0018] Concretely, the invention can be realised according to the following example, the characteristics of which, however, are not to be regarded as limiting the scope of protection in any way.

[0019] A structural member of an electrical device, with such member being formed of a graphite bound by plastics, is produced in a conventional way so that it acquires its final shape. Then, a batch including a large number of the structural members is cleansed and etched by anodic etching in a commercially available device for electrolytic etching in a solution of NaOH having a concentration of 50 % by weight

and at a temperature of 30° to 40°C, followed by a direct transfer to a simple water bath at room temperature. There, the solution displays a transient sparkling around the structural members in the batch. The batch is then rinsed and Pd seeded in a known fashion. For this aim, commercial ionogenic or colloidal Pd-solutions are available. The Pd-seeds serve as a catalyst for the subsequent steps of metallization.

[0020] The anodic etching is performed with an applied electrical potential in the range of 4V to 20V. The preferred range is 9V to 10V. The duration of the anodic etching is between 5 and 90 minutes, with the actual time being inversely proportional to the strength of the applied electrical potential. For example, for the preferred range of 9V to 10V, 30 to 40 mins. are used. For the resultant range of 200 to 500 V min, an approximate preferred range is 300 to 400 V min.

[0021] A Ni-layer having a thickness of 0.1 to 2 μm is chemically deposited (by electroless plating) on the Pd-seeded graphite members. Because the Ni layer is very thin, it may be reinforced by chemical Ni, chemical Cu, galvanic Ni and/or galvanic Cu.

[0022] An electrolytic Sn-alloy may then be applied to the reinforced chemical metal layer to form a layer thickness between 5 and 10 μm so that the solder pads can be directly placed thereupon. A galvanic reinforcement is preferred to a chemical reinforcement. The soldering process itself is completely conventional, since only the surface of the Sn-alloy is essential for it.

[0023] The solder pad offers not only excellent electrical contact with the graphite structural member, but it has such a good adhesion to the graphite structural member, that it may also be employed for mechanical fixation. This avoids fixing the graphite

structural member by clamping or by screwing on via a tapped hole or by other interlocking or frictional connections. One can simply employ a suitable metal stripe as a mounting device.

[0024] The invention is advantageous in that by applying a metal coating to graphite, i.e. the deposition of adhering, and not just surface-mounted, metal layers, such metal layers will provide a valuable contribution for creating electrical contacts on and/or for mechanically fixing graphite structural members. On the one hand, other metallic contact elements can be pressed on these deposited metal layers, so that only comparatively low transition resistances occur. On the other hand, the metal layers can be used as a basis for solder connections or other methods for creating a firm connection to the structural member, which require a metallic surface.